

SECTION 13251 - ACTIVATED CARBON ODOR CONTROL SYSTEMS

City of San Diego, CWP Guidelines

\$# _____

NTS: The DESIGN CONSULTANT shall engage a specialist with expertise in the design of fiberglass structures who shall prepare the design and specifications for the odor scrubbing vessels and ductwork. The specialist shall also provide inspection services for the construction of the equipment. The specifications herein shall be modified by the specialist, as required, to conform to the design.

_____\$

PART 1 -- GENERAL

1.1 WORK OF THIS SECTION

- A. The WORK of this Section includes providing activated carbon odor control systems, with adsorber vessel and activated carbon media, support assembly, associated ductwork, controls, and accessories.
- B. The WORK also requires that a single manufacturer be responsible for furnishing the WORK of this Section without modifying the CONTRACTOR'S responsibility under the Contract Documents.

1.2 RELATED SECTIONS

- A. The WORK of the following Sections applies to the WORK of this Section. Other Sections of the specifications, not referenced below, shall also apply to the extent required for proper performance of this WORK:
 - 1. Section 06610 Glass Fiber and Resin Fabrications, General
 - 2. Section 11000 Equipment General Provisions
 - 3. Section 15860 FRP Ductwork
 - 4. Section 15880 Air Distribution Devices and Accessories

1.3 CODES

- A. The WORK of the Section shall comply with the current editions, with revisions, of the following codes and City of San Diego Supplements:
 - 1. Uniform Building Code
 - 2. Uniform Mechanical Code

1.4 SPECIFICATIONS AND STANDARDS

- A. Except as otherwise indicated, the current editions of the following apply to the WORK of this Section:

NBS PS 15	Custom Contact-Molded Reinforced Polyester Chemical-Resistant Process Equipment.
ASTM A 325	Specification for High-Strength Bolts for Structural Steel Joints.
ASTM A 490	Specification for Heat-Treated Steel Structural Bolts 150 ksi (1035 MPa) Tensile Strength.
ASTM C 581	Practice For Determining Chemical Resistance of thermosetting Resins Used in Glass Fiber Reinforced Structures, Intended for Liquid Service.
ASTM D 638	Test Method for Tensile Properties of Plastics.
ASTM D 695	Test Method for Compressive Properties of Rigid Plastics.
ASTM D 790	Test Methods for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
ASTM D 883	Definitions of Terms Relating to Plastics.
ASTM D 2563	Recommended Practice for Classifying Visual Defects in Glass-Reinforced Plastic Laminate Parts.
ASTM D 2583	Test Method for Indentation Hardness of Rigid Plastics by Means of a Barcol Impressor.
ASTM D 2584	Test Method for Ignition Loss of Cured Reinforced Resins.
ASTM D 3299	Specification for Filament-Wound Glass Fiber Reinforced Thermoset Resin Chemical-Resistant Tanks.
ASTM D 3467	Test Method for Carbon Tetrachloride Activity of Activated Carbon.
AISC	Specification for the Design, Fabrication, and Erection of Structural Steel for Buildings.
NFPA 255	Method of Test for Surface Burning Characteristics of Building Materials.

1.5 SHOP DRAWINGS, SAMPLES, AND CERTIFICATIONS

A. The following shall be submitted in compliance with Section 01300:

1. Shop drawings of activated carbon odor control system.
2. Manufacturer's product data.
3. Manufacturer's installation instructions.
4. Sample of carbon with specifications.
5. Certification by qualified laboratory verifying H₂S breakthrough capacity.
6. Analysis sheets for carbon.
7. Certification by fiber glass reinforced plastic duct supplier as follows:
The resin used has been tested in accordance with ASTM C 581 and that the resin is compatible with an environment consisting of air, caustic solution, hydrogen sulfide gas, methane, various aromatic hydrocarbon vapors, droplets of salt water, and droplets of water containing sodium hypochlorite, sodium hydroxide, and sulfuric acid.
The fiber glass used has a flame spread rating of [25] or less and a smoke developed rating of [50] or less measured in accordance with NFPA Standard No. 255.
8. Certification by vessel manufacturer listing the nomenclature, composition, and characteristics of the resin to be supplied with the submittal data.
9. Reports of tests required by the WORK of this Section.

\$# _____

NTS: Quarterly analysis of activated carbon may not be required if the activated carbon unit is preceded by a chemical scrubber.

_____ #

1.6 QUARTERLY ANALYSIS OF ACTIVATED CARBON

- [A. The CONTRACTOR shall require the carbon manufacturer to supply a quarterly analysis of the activated carbon to the OWNER to be reported as "H₂S capacity." This service shall be furnished for one year from startup of the system. The CONTRACTOR shall have the manufacturer furnish 4 appropriate containers and adequate instructions for taking and submitting samples to the carbon manufacturer or approved outside lab(s).]

1.7 OWNER'S MANUAL

A. The following shall be included in the OWNER'S MANUAL in compliance with Section 01300:

1. Operations and maintenance instructions.
2. List of special tools.
3. List of spare parts recommended by the manufacturer for 2 years' successful operation.

1.8 SERVICES OF MANUFACTURER

- A. **Inspection, Startup, and Field Adjustment:** An authorized service representative of the manufacturer shall visit the site for not less than [] days and witness the following:
1. Installation of the equipment.
 2. Inspection, checking, and adjusting the equipment.
 3. Start-up and field testing for proper operation.
 4. Performing field adjustments to ensure that the equipment installation and operation comply with the specifications.
- B. **Instruction of OWNER'S Personnel:** The authorized service representative shall also instruct the OWNER'S personnel in the operation and maintenance of the equipment including step-by-step troubleshooting procedures with necessary test equipment for not less than [] days.

1.9 FACTORY TESTING

- A. Equipment shall be new and free of defects including blisters, chips, crazing, exposed glass, cracks, burned areas, dry spots, foreign matter, surface porosity, sharp discontinuity or entrapped air at the surface of the laminate. Products shall comply with the tolerances in Table I.

TABLE I
ALLOWABLE FRP PRODUCT TOLERANCES

Defect	Inside Surface	Outside Surface
Blister	None	Max dimension: 1/4-in dia x 1/8-in high; Max density: 1 per sq ft; Min separation: 2 in apart
Chips	None	Max dimension of break: 1/4-in and thickness no greater than 10 percent of wall thickness; Max density: 1 per sq ft
Crazing	None	Max length: 1/2 in; Max density: 5 per sq ft; Min separation: 2 in
Cracks	None	None
Exposed Glass	None	None
Scratches	None	Max length: 1 in;

Max depth: 0.010 in

Burned Areas	None	None
Surface Porosity	None	None
Foreign Matter	None	None
Sharp Discontinuity	None	None
Pits	Max: 1/8 in, dia by 1/32 in deep; Max: 10 per sq ft	Max 1/8 in dia by 1/16 deep; Max: 10 per sq ft
Dry Spot	None	2 sq in per sq ft
Entrapped Air	None at the surface 1/16 in and 10 per sq in max within laminate	1/8 in and 4 per sq in or 1/16 in and 10 per sq in

- B. Prior to any exterior gel coating or equivalent of the vessel, notification must be given to the CONSTRUCTION MANAGER. The CONSTRUCTION MANAGER reserves the right to be present at the fabricators facility for visual inspection of equipment to be supplied.
- C. Prior to shipment, vessels shall be smoke-tested at a pressure of one psi for a minimum of one-hour, with no visible signs of leaks or excessive wall deflection. The CONSTRUCTION MANAGER reserves the right to be present at the fabricators facility during testing.

1.10 FIELD TESTING

- A. After completion of the installation, equipment and systems shall be tested for satisfactory operation without noise, vibration, and overheating. Equipment must be adjusted and checked, for misalignment, clearances, supports, and adherence to safety standards.
- B. Vessels shall be smoke tested at a pressure of one psi for a minimum of one hour with no visible signs of leaks or excessive wall deflection.
- C. Performance of odor control systems shall be tested for [5] [] days minimum, as follows:
 - 1. The performance of the system shall be verified by a [5] consecutive day, 24 hours per day, performance test. H₂S sample collection and testing equipment shall be provided by the CONTRACTOR. Effluent H₂S samples shall be collected and analyzed twice per day. For the purpose of performance testing, the CONTRACTOR shall supply bottled H₂S to simulate design influent H₂S concentrations.

2. The odor control system shall be tested with an influent H₂S concentration of [50] [] ppm for two hours on each of the consecutive test days, with a concentration of [15] ppm the remainder of the time.
3. Hydrogen sulfide (H₂S) concentrations shall be measured using a wet chemical method where a known volume of air is bubbled through a controlled volume of calcium hydroxide and starch solution which absorbs H₂S. H₂S content shall then be analyzed by a titration and colorimetric determination. The CONTRACTOR shall utilize a portable H₂S analyzer to provide rapid feedback during testing. However, the final H₂S determination for evaluating system performance shall be by the above described wet chemical method. H₂S testing shall be conducted by an independent laboratory.
4. **Acceptance Criteria and Tolerances:** Odor control systems shall remove [] percent of the influent hydrogen sulfide (H₂S), as measured in ppm, and [] percent of the odor units.

PART 2 -- PRODUCTS

2.1 GENERAL

- A. **Performance:** Activated carbon adsorber systems shall be designed for the following:

Equipment No.	[]
Location	[]
Number of Systems	[]
Air Flow (cfm)	[]
Facial Velocity (fpm)	[]
Vessel Dimensions (ft)	[]
Bed Type (dual) (single)	[]
Media Depth (2 beds) (ft)	[]
Maximum Air Pressure	[]
Loss Across Adsorber Inlet to Outlet at Design Flow, (inches W.C.)	[]

- B. **Power Supply:** Except as otherwise indicated, the power supply to the equipment shall be 480-volt, 60-Hz, 3-phase.

2.2 ADSORBER VESSEL

- A. [] [3] fabricated fiber glass reinforced plastic adsorber vessels, as indicated, with fittings, shall be provided. The fiber glass vessels shall comply with Section 06610 and shall be fabricated of filament wound fiber glass in accordance with the NBS PS 15.

- B. Vessel shall have a stack connected to the vessel top, as indicated, or exhaust ducts, supported by the vessel. The stack shall terminate with a Type 316 stainless steel bird screen.
- C. Resins shall be suitable for continuous exposure to saturated hydrogen sulfide gas and periodic 48-hour exposure to 50 percent caustic solution.
- D. Resin shall be reinforced with an interior Type C fiber glass veil and an exterior continuous, even-tensioned fiber glass filament wound or hand lay-up reinforcement and shall include gel coat to ensure that no glass fiber is exposed. Final gel coat shall be ferro-white or equivalent. The color of the gel coat shall be selected by the CONSTRUCTION MANAGER.
- E. The fiber glass shall contain an ultraviolet absorber to protect the resin from ultraviolet degradation.
- F. The vessel shall be constructed in accordance with the following provisions.

LAMINATE PHYSICAL PROPERTIES (73 degrees F.)

	Thickness (Inches)			
	<u>3/16</u>	<u>1/4</u>	<u>5/16</u>	<u>3/8 and up</u>
Ultimate tensile strength ASTM Method D 638 - psi min	9,000	12,000	13,500	15,000
Modulus of elasticity Procedure A of ASTM Method D 790 (tangent) - psi	7x10 ⁵	8x10 ⁵	9x10 ⁵	10x10 ⁵
Flexural strength Procedure A of ASTM Method D 790 - psi min	16,000	19,000	20,000	22,000
Compressive edge strength ASTM D 695 - psi min	18,000	18,000	20,000	20,000
Glass content by ignition	20% to 28%		Minimum 28%	

- G. Surfaces shall be smooth with no exposed fiber, sharp projections, foreign inclusions, air bubbles, pinholes, or delaminations.
- H. The inner corrosion barrier shall be a resin rich barrier of 10-15 mil minimum not to exceed 20 percent \pm 5 percent glass by weight. Glass shall be of non-continuous fiber. The inner corrosion

barrier shall be followed by not less than 2 layers of chopped-strand mat or 2 passes of chopped roving to a total of 3 ounces/ft². Where the chopped-roving technique is indicated, chopped fibers shall be 1/2-inch to 2 inches in length. The inner corrosion barrier plus the 2 mat layers shall total 100 mils minimum and be 27 percent \pm 5 percent glass by weight.

- I. The vessel shall have an average glass content of 55 percent \pm 5 percent by weight per ASTM D 2584.
- J. The fiber glass vessels shall be furnished with fittings, lifting hooks, painted lifting instructions, and accessories indicated, including but not limited to manways with covers for access to the carbon beds, handways with covers for access to air plenums, a flanged cover for access through the top of the carbon vessel, a blind flange for the air inlet connection to provide leakproof shut-off during regeneration, an FRP flanged connection with isolation valve for connection to plant drain system to drain regeneration solution, pressure taps upstream and downstream of each carbon bed for measurement of pressure drop, and three sample probes evenly spaced in each carbon bed. No press molded or compression molded flanged nozzles are acceptable. All cut walls shall be reinforced as required by service conditions. Covered access ways, sample probes, pressure taps, and drain connections shall be air and watertight.

2.3 ACTIVATED CARBON

- A. Sufficient activated carbon shall be provided to fill the adsorbers to the indicated bed depth. The activated carbon shall be granular, derived from bituminous coal, vapor-phase type suitable for control of sewage treatment odors. The carbon shall comply with the following:

CCl ₄ Number, percent by weight (complying with ASTM D 3467)	[60]
Iodine Number, Minimum	[1050]
Mean Particle Diameter, Minimum	[3.6 mm]
Apparent Density	[0.47 g/cc minimum]
Hardness Number, Minimum	[93]
Moisture, Maximum (Calculated on total product basis)	[2 percent]
Voids in Dense Packed Column	[43 percent]
Maximum Head Loss (W.C.) @ 50 fpm Linear Velocity	[1.9-in (W.C.)/Ft. Bed Depth]
H ₂ S Breakthrough Capacity, Minimum	[0.12 g H ₂ S Removed/cc Carbon]

The determination of H₂S breakthrough capacity will be made by passing a moist (85 percent R.H.) air stream containing one percent H₂S at a rate of 1,450 cc/min through a 0.725-inch diameter by 6-inch deep bed of uniformly packed activated carbon and monitored to 50 ppmv breakthrough. Results are expressed in grams H₂S removed per cc of carbon.

- B. The carbon shall be of a type chemically regenerable in-place by the use of 50 percent or less caustic solution.

2.4 FIBERGLASS FANS

- A. **General:** The activated carbon adsorber fans shall be backward-inclined blade, V-belt driven, centrifugal fans designed for continuous 24-hour per day service. The fan housing, impeller, inlet flange, and outlet flange shall be constructed of fiber glass reinforced plastic in compliance with Section 06610 and NBS PS 15. The surface of all fiber glass reinforced plastic in contact with the odorous air shall be corrosion resistant. The exterior surface of the fiber glass reinforced plastic in contact with the atmosphere shall be finished with gel coat. The finished exterior shall be smooth with no exposed fiber, sharp projections, foreign inclusions, air bubbles, pin holes, or delaminations. The steel shaft and all other metal parts in contact with the odorous air shall be encapsulated with fiber glass reinforced plastic.
- B. The fan inlet and outlet shall have integral transitions to circular or rectangular plain collar openings as indicated. The plain collar ends shall be suitable for attachment to flexible duct connectors complying with Section 15880. The fan shall be statically and dynamically balanced at operating speed. The fan housing shall be equipped with a threaded PVC drain coupling and shut-off valve at its lowest point. The fan and motor support base shall be of heavy gage steel construction.
- C. The fan motor shall be a heavy duty type, TEFC, for 480-volt, 3-phase, 60-Hz power supply. The belt drive shall be dual sheave and belt. Each belt shall be capable of driving the fan at rated capacity if the other belt breaks. A sliding motor base plate shall be included for belt tension adjustment.
- D. The fans shall comply with the applicable standards of the Air Movers and Conditioners Association and the following:

Equipment No.	-	[]
Location	-	[]
Number of Fans	-	[]
Capacity (cfm)	-	[]
Pressure (inches W.C.)	-	[]
Maximum Fan Speed (rpm)	-	[]
Maximum Brakehorse power (hp)	-	[]
Motor Horsepower (hp)	-	[]

Inlet Diameter (inches) - []

2.5 FLOW MONITORING

- A. Adsorption systems shall include flow measuring equipment designed to provide direct readout of total air flow in CFM and operating pressure in inches of water column.

2.6 STATIC GROUNDING OF CARBON BEDS

- A. Carbon beds shall be properly grounded.

2.7 CONTROLS

- A. The operation of each odor control system shall be controlled from a local odor control panel with panel equipment, operational sequences, and indication/alarm functions.
- B. The panel shall contain HANDS-OFF-AUTOMATIC switches, or ON-OFF switches and fan indicating lights, [and it shall monitor the inlet and exhaust foul air H₂S concentrations]. Each panel shall contain necessary relays, contacts, timers, microswitches, terminals, latches, and programmable controllers designed to operate the odor control system and transmit signals. Transformers, disconnect switches, circuit breakers, and motor starters for fans shall be contained in the nearest motor control center. Each control panel shall have a NEMA rating in accordance with the area designations of Section 16050. Panels shall be free-standing, mounted on a stainless steel frame, and pre-wired with factory-mounted instruments, controls, and indicators.

2.8 HYDROGEN SULFIDE MONITORING SYSTEM

- A. **General:** A hydrogen sulfide (H₂S) monitoring system consisting of H₂S sensors, H₂S monitors, ambient air H₂S monitors and associated piping, conduit, wiring and appurtenances shall be installed where indicated.
- B. **H₂S Sensors:** [] H₂S sensors shall be provided. One sensor shall be provided on each scrubber vessel exhaust stack, and one sensor shall be provided in each foul air duct leading into the scrubber system. In addition, ambient air H₂S sensors shall be mounted where indicated. The ambient H₂S sensors shall be mounted between 7 and 9 feet above the floor. The sensors shall be solid-state, semi-conductor diffusion/adsorption type units and shall include conduit with wire to the ambient H₂S sensors. The sensors shall sense from 0 to 10 ppmv in less than 10 seconds with 50 ppmv H₂S applied. The sensors shall be 100 percent clear in less than 3 minutes. The sensors shall detect from 0 to 100 ppmv of H₂S and shall exhibit no loss of sensitivity or response time due to lack of exposure or prolonged exposure to H₂S. The operating temperature range of the sensors shall be [-30] degrees F to [+150] degrees F.
- C. **H₂S Monitors:** H₂S monitors shall be installed in each odor control system local control panel (LCP). Each monitor shall have two channels for continuous readout of system influent and exhaust H₂S concentration in ppmv. H₂S signals from each odor control system and the ambient H₂S monitors shall be sent to the main control board for indication. [In addition ambient H₂S sensors shall send signals to single channel monitors where indicated.] Each monitor shall indicate H₂S concentration in a range of 0 to 100 ppmv. Monitors shall be equipped with channel selector switch with channelscan mode, for monitors with two or more channels, high and low level alarms and reset

buttons for each channel, and malfunction alarms and reset buttons for each channel. The H₂S monitors shall have automatic calibration with no zero or pot adjustments.

- D. **Cables:** The CONTRACTOR shall provide cables between the H₂S sensors and H₂S monitors and the H₂S monitors and the Odor Control LCPs.
- E. **H₂S Calibrator:** One portable H₂S calibrator shall be provided to calibrate the H₂S monitors. The calibrator shall have an output range of 20 to 100 ppm and shall be equipped with a 12-volt dc rechargeable battery. An electrically-driven diaphragm pump shall be provided to convey the H₂S to the instrument to be calibrated.

2.9 MANUFACTURERS

- A. **Manufacturers:** Products shall be manufactured by one of the following (or equal):

- 1. Fiberglass Fans:

New York Blower
Hartzell

- 2. Hydrogen Sulfide Monitoring System:

Texas Analytical Controls, Inc.
Rexnord Gas Detection Products

- 3. Hydrogen Sulfide Calibrators:

Rexnord
Sierra Monitor Corporation

- 4. Activated Carbon Odor Control System:

Calgon Co.
Ceilcote Co.
Westates Co.

PART 3 -- EXECUTION

3.1 GENERAL REQUIREMENTS

- A. The odor control system shall be installed in accordance with the manufacturer's installation instructions.

3.2 WORKMANSHIP

- A. **Ductwork and Fiberglass Items:** Products shall be free from visual defects including inclusions, dry spots, air bubbles, pin holes, pimples, delamination, exposed reinforcement (glass fibers), and runoff. Exterior surface shall be smooth with no sharp projections. Care shall be taken to fill voids and crevices at joints and fittings.
- B. **Supports:** Ductwork shall be supported at least every 5 feet. Supports shall be fabricated of galvanized steel and designed to meet the installation requirements. Attachment of the supports to fiber glass ducting with screws is unacceptable. Fiberglass vessels and major sections of ductwork shall include lifting lugs or eyes to facilitate handling and installation.

3.3 FIELD JOINTS IN FIBERGLASS DUCTS

- A. Field joints in fiber glass ducts shall be made by wrapping with strips of reinforcement saturated with resin; the reinforcement shall be at least the thickness of the heaviest plastic section being joined. Extension to a sufficient distance on each side of the joint is required to make the joint at least as strong as the pieces jointed. Mating edges shall be filled with resin paste to cover cut edges and fill voids. The inside surface of the joint shall be sealed with one layer of reinforcement where accessible.

** END OF SECTION **